

## **Manned Mission Planning Considerations when Using a Non-Regenerable CO2 Removal System**

As the commercial spacecraft industry increases in size, there will be a corresponding increase in the number of manned spacecraft built and operationally flown each year. Industry teams for these new spacecraft will have multiple design and operational choices to make for each of these spacecraft's subsystems. The carbon dioxide (CO<sub>2</sub>) removal subsystem of the environmental control and life support system is one that presents such challenges. This paper seeks to aid industry in making design and operations choices by providing a document containing lessons learned by the Space Shuttle Program's Operations team, with specific focus given to the non-regenerable CO<sub>2</sub> removal system currently used by the Space Shuttle. Carbon dioxide, one of the key byproducts of respiration, can lead to injury and death if allowed to build up in a spacecraft's habitable environment. Therefore, any spacecraft's environmental control and life support system must contain a method for removing this hazard. These removal systems can either be non-regenerable or regenerable. While this paper defines the difference between these types and presents a generic comparison of their capabilities, the focus is specifically on the Space Shuttle's CO<sub>2</sub> removal systems. This will include a short discussion of the Space Shuttle's regenerable amine solid absorption system that was part of the Extended Duration Orbiter (EDO) modification, however, emphasis is given to the non-regenerable Lithium Hydroxide canister system used as the prime removal method employed by the Space Shuttle, including a discussion on why this method was chosen over a regenerable system. A full exposition is given on all of the considerations required for mission planning when using a non-regenerable CO<sub>2</sub> removal system. Key discussion items include: airflow lessons learned, recent physiological issues related to short term and long term exposure and how lower levels may be more harmful than previously thought, lithium hydroxide dust issues, mass vs. stowage comparisons, cost, complexity considerations, operational margin considerations, timing considerations with respect to the crew's schedule, and logistical management. The conclusion of the paper finalizes the discussion and contains a listing of considerations in regards to CO<sub>2</sub> management using a non-regenerable removal system in the near future.